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Lecture title: **Enteric nervous system**

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Summary:

Enteric nervous system

The enteric nervous system, which can be considered as the third division of the ANS, is located within the wall of the digestive tract, all the way from the esophagus to the anus. It is comprised of two well-organized neural plexuses.

*The myenteric plexus: is located between longitudinal and circular layers of muscle; it is involved in control of digestive tract motility.

*The submucosal plexus: is located between the circular muscle and the luminal mucosa; it senses the environment of the lumen and regulates gastrointestinal blood flow and epithelial cell function.

The enteric nervous system contains as many neurons as the entire spinal cord. It is sometimes referred to as a "minibrain" as it contains all the elements of a nervous system including sensory neurons, interneurons, and motor neurons.

*It also contains sensory neurons innervating receptors in the mucosa that respond to mechanical, thermal, osmotic, and chemical stimuli.

*Motor neurons control motility, secretion, and absorption by acting on smooth muscle and secretory cells.

* Parasympathetic and sympathetic nerves connect the central nervous system to the enteric nervous system or directly to the digestive tract.

*Although the enteric nervous system can function autonomously, normal digestive function often requires communication between the central nervous system and the enteric nervous system.

There Are General Differences in Sympathetic and Parasympathetic Function

Although the sympathetic and parasympathetic systems are both important for homeostasis, there are some important general differences in their function.

In physical and some emotional stress, the sympathetic system is capable of a massive, coordinated output with widespread effects on tissues and organs of the body. This causes an increase in heart rate and blood pressure; dilation of the pupil of the eye; an elevation in levels of blood glucose and free fatty acids; and an increased state of arousal. These widespread effects mobilize the body's resources for extra effort in responding to an emergency. Therefore the sympathetic system is sometimes referred to as the fight or flight system. The effect of sympathetic discharge not only is widespread but can last longer than effects of parasympathetic discharge because of the prolonged circulation of epinephrine and norepinephrine. Indeed, the adrenal medulla's secretion of epinephrine and norepinephrine into the circulating blood provides prolonged adrenergic stimulation to the entire body, even to some tissues that do not have direct sympathetic postganglionic stimulation.

Under less stressful conditions the sympathetic system plays an important role in homeostasis, but with less universal control within the body. For example, sympathetic control of the skin for thermoregulation, or of the dilator smooth muscle in the iris for enlargement of the pupil in low ambient light, can respectively occur without extensive activation of other organs.

The parasympathetic system is characterized by a greater degree of independent control of tissues and organs, as well as a more precise control within a given tissue or organ, compared with the sympathetic system. In addition, unlike the sympathetic system which innervates virtually all parts of the body, the parasympathetic system does not innervate structures of the body wall and extremities. The parasympathetic system is generally concerned with the restorative aspects of daily living. For example, parasympathetic stimulation assists digestion and absorption of food by increasing gastric secretion, increasing intestinal motility, and relaxing the pyloric sphincter. For this reason, the parasympathetic nervous system is sometimes called the anabolic or restorative nervous system, as well as the rest and digest system.

Many organs of the body have both sympathetic and parasympathetic innervation, each with a reciprocal effect. For example, sympathetic stimulation increases heart rate, whereas parasympathetic stimulation decreases heart rate. Sympathetic stimulation enlarges pupillary diameter, whereas parasympathetic stimulation causes pupillary constriction. These sympathetic and parasympathetic systems work together, along with the enteric system, to exquisitely keep the body's internal environment stable. The table gives a more complete listing of the responses of various organs to adrenergic and cholinergic stimulation by the peripheral autonomic nervous system.

Autonomic Effects on Various Organs of the Body

Organ	Effect of Sympathetic Stimulation	Effect of Parasympathetic Stimulation
Eye		
Pupil	Dilated	Constricted
Ciliary muscle	Slight relaxation (far vision)	Constricted (near vision)
Glands	Vasoconstriction and slight secretion	Stimulation of copious secretion (containing many enzymes for enzyme-secreting glands)
Nasal		
Lacrimal		
Parotid		
Submandibular		
Gastric		
Pancreatic		
Sweat glands	Copious sweating (cholinergic)	Sweating on palms of hands
Apocrine glands	Thick, odoriferous secretion	None
Blood vessels	Most often constricted	Most often little or no effect
Heart		
Muscle	Increased rate Increased force of contraction	Slowed rate Decreased force of contraction (especially of atria)
Coronaries	Dilated (β_2); constricted (α)	Dilated
Lungs		
Bronchi	Dilated	Constricted
Blood vessels	Mildly constricted	? Dilated
Gut		
Lumen	Decreased peristalsis and tone	Increased peristalsis and tone
Sphincter	Increased tone (most times)	Relaxed (most times)
Liver	Glucose released	Slight glycogen synthesis
Gallbladder and bile ducts	Relaxed	Contracted
Kidney	Decreased output and renin secretion	None
Bladder		
Detrusor	Relaxed (slight)	Contracted
Trigone	Contracted	Relaxed
Penis	Ejaculation	Erection
Systemic arterioles		
Abdominal viscera	Constricted	None
Muscle	Constricted (adrenergic α) Dilated (adrenergic β_2) Dilated (cholinergic)	None
Skin	Constricted	None
Blood		
Coagulation	Increased	None
Glucose	Increased	None
Lipids	Increased	None
Basal metabolism	Increased up to 100%	None
Adrenal medullary secretion	Increased	None
Mental activity	Increased	None
Piloerector muscles	Contracted	None
Skeletal muscle	Increased glycogenolysis Increased strength	None
Fat cells	Lipolysis	None

"ALARM" OR "STRESS" RESPONSE OF THE SYMPATHETIC NERVOUS SYSTEM

When large portions of the sympathetic nervous system discharge at the same time—that is, a mass discharge—this action increases the ability of the body to perform vigorous muscle activity in many ways, as summarized in the following list:

1. Increased arterial pressure.
2. Increased blood flow to active muscles concurrent with decreased blood flow to organs such as the gastrointestinal tract and the kidneys that are not needed for rapid motor activity.
3. Increased rates of cellular metabolism throughout the body.
4. Increased blood glucose concentration.
5. Increased glycolysis in the liver and in muscle.
6. Increased muscle strength.
7. Increased mental activity.
8. Increased rate of blood coagulation.

The sum of these effects permits a person to perform far more strenuous physical activity than would otherwise be possible. Because either mental or physical stress can
excite the sympathetic system, it is frequently said that the purpose of the sympathetic system is to provide extra activation of the body in states of stress, which is called
the sympathetic stress response.

The sympathetic system is especially strongly activated in many emotional states. For example, in the state of rage, which is elicited to a great extent by stimulating the hypothalamus, signals are transmitted downward through the reticular formation of the brain stem and into the spinal cord to cause massive sympathetic discharge; most aforementioned sympathetic events ensue immediately. This is called the sympathetic alarm reaction. It is also called the fight-or-flight reaction because an animal in this state decides almost instantly whether to stand and fight or to run. In either event, the sympathetic alarm reaction makes the animal's subsequent activities vigorous.